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ORIGINAL PAPER

The influence of a virtual companion on amusement when watching funny films

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Abstract We investigated the role of a virtual companion and trait cheerfulness on the elicitation of amusement. Ninety participants watched funny films in four conditions: either alone, with a virtual companion laughing or verbally expressing amusement at fixed time points (pre-scripted), or additionally joining the participant's laughter (responsive companion). Amusement was assessed facially and vocally by coding Duchenne Displays and laughter vocalizations. Participants' cheerful mood pre and post the film watching and positive experience were assessed. Results showed that high trait cheerful individuals generally experienced and expressed more amusement than low trait cheerful individuals. The presence of a virtual companion (compared to being alone) led to more laughter for individuals low in trait cheerfulness. Unexpectedly, the responsive companion did not elicit more amusement than the pre-scripted companion. The general disliking of virtual companions and gelotophobia related negatively to amusement. Amusement expressing virtual companions may be used in interventions aiming at eliciting positive responses, especially for individuals with higher thresholds for amusement.

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Introduction

Amusement is a facet of the positive emotion of joy (Ekman 2003) and is typically elicited by humorous stimuli (e.g., funny films; see Ruch 2009). Amusement can be described at the behavioral (Duchenne smiling and laughter; e.g., Keltner and Bonanno 1997; Ruch and Ekman 2001; Shiota et al. 2003), the physiological (e.g., changes in skin conductance) and the experiential level (cheerful mood, feelings of amusement; see Ruch 2009). Although there is a myriad of (humorous) situations and stimuli that can elicit amusement, it has been shown that the presence of another person (companion) greatly enhances amusement responses on several factors (e.g., Chapman and Chapman 1974). For example, the frequency and duration of smiling and laughter in response to humorous stimuli is impacted by the presence of a laughing versus a non-laughing model person. Further factors, such as the responsiveness of the companion, the seating position, and proximity to the companion, as well as eye contact, age difference between the companion and the subject, whether groups of strangers or friends are together, and the group size have been investigated and shown to be influential (i.e., leading to more overt amusement responses; e.g., Devereux and Ginsburg 2001; Levy and Fenley 1979; Wimer and Beins 2008). Furthermore, the current mood influences the effects of the increased amusement due to the presence of a companion: Only high state cheerful individuals smiled more by the mere presence of another person, but this was not so for individuals that were not in a cheerful mood (e.g., Deckers 2007). Also, personality may influence such amusement elicitation processes (see Ruch and Hofmann 2012).

Based on these findings, four aspects are of interest in the current study: firstly, to investigate whether amusement expressing (responsive) *virtual* companions[1] increase amusement responses (as human companions do) when watching funny films compared to being alone. Secondly, we investigate whether individuals high and low in trait cheerfulness profit alike from being with a virtual companion compared to being alone. Thirdly, we investigate whether a responsive virtual companion increases amusement more than an independent/pre-scripted acting virtual companion (only responding to the films, but not to the participant). Fourth, factors hindering the elicitation of amusement through a laughing virtual companion are investigated. The general dislike of virtual companions and gelotophobia (the fear of being laughed at, for a review see Ruch et al. 2014) are considered to hinder amusement when being with a virtual companion. As criteria, several amusement indicators are assessed: amusement related smiles (Duchenne Displays, DDs; Ekman et al. 1990), laughter vocalizations, self-reported positive experiences and changes in cheerful mood.

Research on amusement in social virtual environments and virtual companions is relatively novel. Hence, the putative facilitation of amusement and laughter contagion through virtual companions and their expression of humor appreciation in face and voice received only little empirical attention so far (see Niewiadomski et al. 2013). Investigations of a laughing virtual companion facilitating amusement (similarly to human companions) when participants are exposed to funny stimuli (i.e., watching funny films) are scarce. Such data will break ground for the improvement of social human–machine interactions in virtual environments by the facilitation of amusement and laughter through an adequately laughing virtual companion. The positive affect might make individuals engage more, or with more pleasure, in human–machine interactions. This would be useful for various domains: For example, Göritz (2007) showed that not all established induction methods of positive affect work in internet settings, and a laughing virtual companion could help overcoming such problems. Also, it might be interesting to assist the elicitation and upregulation of amusement in online interventions for outcomes like enhanced pain thresholds and stress reduction (see for example Cohn et al. 2009; Giuliani et al. 2008; Papa and Bonanno 2008; Zweyer et al. 2004). In such interventions, a virtual companion could serve as an accompanying online tutor, social partner, or instructor next to amusement fostering exercises (or being part of the exercise itself). Thus far, little is known about the assistance of a virtual companion in the amusement elicitation and laughter contagion in general.

In comparison to virtual companions, laugh tracks could also be easily implemented in internet environments. Although laugh tracks have been shown to influence individual's amusement responses (see for example Fuller and Sheehy-Skeffington 1974; Olson 1992; Platow et al. 2005), they are typically pre-scripted and vocal only. In comparison, virtual companions exhibit amusement facially and verbally, which might lead to a stronger fostering of amusement. Furthermore, virtual companions encourage a feeling of social companionship that a laugh track could not, as there is no embodiment or responsiveness in the latter.

Furthermore, it needs to be clarified whether individuals either predisposed to experience amusement (i.e., those high trait cheerfulness) or habitually having higher thresholds for amusement (i.e., low trait cheerful individuals; see Ruch and Hofmann 2012) respond differently to the amusement elicitation with a virtual companion. Trait cheerfulness has been postulated and empirically validated to be an enduring disposition to experience and express positive emotions (starting with Meumann 1913, who saw cheerfulness as one of 12 basic temperaments, for an overview: Ruch and Hofmann 2012). Therefore, trait cheerfulness is an important predictor for the elicitation of amusement (i.e., when watching funny films), but it is unknown how the trait interacts with the presence of a virtual companion on the elicitation of amusement.

Trait cheerful individuals should experience more amusement while watching funny films than low trait cheerful individuals, as they have a lower threshold for smiling and laughter, those behaviors are more contagious, and there are generally more elicitors of amusement to high trait cheerful individuals. High trait cheerful individuals readily engage in amusing interactions and they also experience more amusement than those low in trait cheerfulness in elicitors free of context, like laughing gas or the herb kava–kava (see Thompson et al. 2004). On the contrary, low trait cheerful individuals have generally higher thresholds for the experience and expression of amusement compared to high trait cheerful individuals. Consequently, low trait cheerful individuals may need more support than high trait cheerful individuals to experience amusement and to get into a cheerful mood. It might be that low trait cheerful individuals express amusement more frequently

[1] We use the term virtual companion to denominate a virtual agent in specific social interactions. Virtual agents (VA) are computer generated animated characters that are able to interact verbally and also nonverbally with human users, including reactions to the human behaviors and displaying autonomous "pro-active" behaviors. VAs have a graphical representation, usually humanoid. Being a metaphor of human behavior, these agents are expected to display/communicate several complex behaviors such as emotions or social skills.

when being encouraged by a virtual companion, compared to being alone. Therefore, we hypothesize that the interaction with a laughing virtual companion will have a bigger positive impact (i.e., lead to more overt amusement responses) on low than on high trait cheerful individuals, as they would benefit more from the support or respond stronger to the "social facilitation" of the "adequate response" (i.e., laughter). This would be in line with findings from a cheerfulness intervention, where low trait cheerful individuals experienced stronger positive effects, such as enhanced cheerfulness, well-being and subjective health (see Papousek and Schulter 2008).

While cheerfulness fosters the elicitation of amusement through a laughing virtual companion, other traits may hinder such effects: Gelotophobia (fear of being laughed at, Ruch and Proyer 2008) systematically biases laughter perception and evaluation. Individuals with a fear of being laughed at do not perceive laughter as joyful or relaxing and they fear being laughed at especially in ambiguous situations (see Ruch et al. 2014 for a review). Also, gelotophobes respond with less DDs when confronted with amusement-related scenarios than individuals with no fear (e.g., Platt et al. 2013; Ruch et al. 2015). We assume that individuals high in gelotophobia interpret a laughing virtual companion as a threat and the induction of amusement would consequently be hindered. A study on social anxiousness (Vrijsen et al. 2010), a concept partially overlapping with gelotophobia (though being sufficiently distinct; see Ruch et al. 2014) showed that in general, individuals high in social anxiety did not appreciate the subtle mimicry behavior of virtual agents and it is assumed that the same would be true for gelotophobes when confronted with the laughter of a virtual companion. Therefore, the relationship of gelotophobia to amusement responses (smiling and laughter, positive experience, cheerful mood) should be investigated. Further, the general acceptance of virtual companions has been shown to be a predictor of subsequent evaluations of a virtual agent's perceived naturalness (see Niewiadomski et al. 2013). Therefore, it is assumed that generally disliking virtual companions (i.e., not accepting) hinders the amusement elicitation, or lead to feelings of distraction by the virtual companion.

Present research

In the current study, the difference in the frequency and intensity of elicited amusement for being alone versus being with a virtual companion was a test of the "social" influence of the laughing virtual companion. Firstly, hypothesis H1 assumed that being with a virtual companion would lead to more frequent amusement in the face (DDs) and voice (laughter vocalizations), and more intense amusement in self-reports (positive experience, cheerful mood) compared to being alone (similar to a human companion see e.g., Devereux and Ginsburg 2001). Secondly, we hypothesized that high trait cheerful individuals would generally experience more amusement than low trait cheerful individuals in all conditions (H2a). Furthermore, low trait cheerful individuals would experience more frequent amusement when being with a companion compared to being alone, as they need more "facilitation" to experience amusement (H2b). Thirdly, we tested the amusement elicited by the virtual companion with respect to whether the companion acts pre-scripted to the funny films or is also responsive to the participant (H3). We hypothesized that the responsive companion elicits more amusement than the pre-scripted acting companion (H3). This effect is linked to possible "mimicry" and emotional contagion processes (see Bourgeois and Hess 2008) elicited by the laughter of the responsive companion. Through the participants' mimicry of the virtual companions' laughter, more laughter is in turn triggered in the responsive companion, as it reacts to the participant's laughter too. This might again increase the mimicry of the participant, leading to an upward spiral of amusement (in the best case). Fourth, the disliking (i.e., generally not accepting) of virtual companions and gelotophobia were investigated for their relationship to the elicited amusement (H4). We hypothesized that generally disliking virtual companions (H4a) and gelotophobia (H4b) hinders the elicitation of amusement.

Four film watching conditions were designed: Three conditions included the presence of a virtual companion, and one control condition did not (i.e., watching films alone). In two *fixed conditions*, the virtual companion expressed amusement verbally (short phrases) or non-verbally (laughter), but did so independently of the participant in response to the funny films at pre-selected fixed time points. In the *responsive laughter condition*, the virtual companion reacted to the participant's laughter and joined in with the laughter. This means that the virtual companion responded to the participant's behavior, which may facilitate mimicry and emotional contagion[2] of amusement, similarly to a human companion (e.g., Brown et al. 1980). The amusement was assessed objectively by nonverbal amusement responses (DDs and laughter vocalizations) coded from videos (participants were filmed while

[2] Emotional contagion is closely related to mimicry (Hess and Blairy 2001) and occurs spontaneous in the observer (Hatfield et al. 1993). Studies have shown that mimicry and emotional contagion occur often, that positive emotions are mimicked more frequently than negative ones, and that motor regions associated with producing facial expressions are activated when hearing emotional vocalizations of amusement (e.g., Bourgeois and Hess 2008; Scott et al. 2010).

watching the funny films), and subjectively by self-reported positive experience and changes in cheerful mood. The assessment of smiles and laughs with the Facial Action Coding System (FACS; Ekman et al. 2002) helped substantiating the findings of the self-reports on the positive experience and cheerful mood. Personality and mood were assessed by questionnaires (STCI; Ruch et al. 1996, 1997; GELOPH<15>; Ruch and Proyer 2008).

Methods

Participants

The sample consisted of 90 adult volunteers (71 females, 19 males; age ranged from 18 to 49, $M = 23.45$ $SD = 4.86$) randomly assigned to one of four conditions: 30 participants in the control condition (*alone*),[3] 20 in the *fixed verbal amusement* condition (FVA), 21 in the *fixed laughter* (FL) and 19 in the *responsive laughter* condition (RL). A Chi square test indicated that the conditions did not differ in the number of males and females assigned, χ^2 $(df = 3) = 2.37$, $p = .499$.

Instruments

Cheerfulness (CH; "I am a merry person"), seriousness (SE; "When I communicate with other people, I always try to have an objective and sober exchange of ideas") and bad mood (BM; "I am often sullen") were assessed by the *State-Trait-Cheerfulness-Inventory* (STCI; Ruch et al. 1996, 1997). The STCI-T measures the respective traits (60 items), and the STCI-S the states CH, SE, and BM (30 items) on a four-point scale ranging from 1 = *strongly disagree* to 4 = *strongly agree*. Ruch and Köhler (2007) report high internal consistencies for the traits (Cronbach's alpha range between .88 and .94). The 1-month retest-stability was high for the traits (between .77 and .86) but low for the states (between .33 and .36), confirming the nature of enduring traits and transient states. In the present sample, the internal consistencies were high (traits: CH $\alpha = .89$; SE $\alpha = .87$; BM $\alpha = .94$; states at three measurement time points: CH $\alpha > .89$, SE $\alpha > .88$, BM $\alpha > .91$). Carretero-Dios et al. (2011) found very high convergent and discriminant validity for the scales of the STCI-T and STCI-S by analyzing self-report and peer-report (three friends) data on the STCI-T, as well as aggregated state data (STCI-S on eight successive days).

The *GELOPH<15>* (Ruch and Proyer 2008) is the standard questionnaire for the assessment of the level of gelotophobia ("When they laugh in my presence I get suspicious") consisting of fifteen items in a four-point answer format (1 = *strongly disagree* to 4 = *strongly agree*). A variety of studies supported the high internal consistency, stability (test–retest correlation), and validity of the GELOPH<15> (see e.g., Edwards et al. 2010; Renner and Heydasch 2010; Ruch et al. 2014). In the current sample, the Cronbach's alpha was very high ($\alpha = .93$). Ruch and Proyer (2008) suggest empirically derived cut-off points that allow differentiating different levels of the fear of being laughed at. Mean scores ≥ 2.50 in the GELOPH<15> indicate at least a slight expression of gelotophobia.

To evaluate the general acceptance of virtual companions and positive experience elicited by the virtual companion, a short form the *Laughing Avatar Interaction Evaluation Form-Revised* (LAIEF-R; Hofmann et al. 2012) was utilized. The general acceptance is assessed by a seven item scale that is given to all participants before the experiment. The 20-item scale on positive experience is given to all participants in the virtual companion conditions after the film watching task.[4] Items are formulated using the term "avatar" instead of "virtual agent", as this is more easily understandable to laypersons (e.g., "In general, I enjoy interacting with avatars"). Further, a short description of the term "avatar" is provided ("avatars are virtual images of humans that appear for example in computer games and on websites"). All items are positively keyed and judged on a seven point Likert-scale (1 = *strongly disagree* to 7 = *strongly agree*). The internal consistencies were computed for the conditions separately (*acceptance* Cronbach's alpha > .88; and *positive experience* > .89).

Stimulus films

The stimulus films consisted of nine film clips (five candid camera pranks of incongruity-resolution humor and four nonsense humor clips, total duration of 15:54 min; candid camera clips: Min = 78.00 s, Max = 131.00 s; $M = 89.60$ s, $SD = 24.99$ s; nonsense humor clips: Min = 88.00 s, Max = 165.00 s, $M = 126.00$ s, $SD = 39.12$ s). For the candid camera clips approximately 4 h of film clips were screened and five culturally unbiased pranks were chosen for the final inclusion (see

[3] Due to technical problems with the recordings, missing data occurred for some participants (e.g., the audio recording was good, but the film was too dark and therefore could not be coded; the camera software crashed during the experiment, the audio stream was not recorded sufficiently, the participant forgot to complete the last page of the questionnaire package). For this reason, we recruited 30 participants (instead of 20) for the control condition, in order to compensate for the data loss.

[4] Items targeting the quality of the technical system (15 items, *technical features scale*) were omitted in the current analysis since they specifically target the architecture of the system.

Niewiadomski et al. 2013). The nonsense humor clips included (1) a comic cat deceitfully waking up its owner (Simon's Cat), (2) a clumsy dentist patient (Mr. Bean), (3) a puppet dancing in a comedy show, and (4) a compilation of dog film clips involved in funny misfortunes. Pre-tests of the funniness of the film clips were obtained from 10 to 14 raters, which rated each clip for its continuous funniness.

Conditions

The participants were asked to watch a film together with the virtual companion (an example of the virtual companion can be viewed on http://www.ilhaire.eu/demo~Laugh-Machine) or alone (control condition). The virtual companion conditions were designed to alter the expressed amusement in either verbal or non-verbal behavior, as well as the responsiveness to the participant's behavior (fixed vs. responsive). In the *"fixed verbal amusement"* condition (FVA), the virtual companion expressed verbal appreciation in 22 short phrases (e.g., "oh, that is funny")[5] at the pre-defined time points. In the *"fixed laughter"* condition (FL), the companion expressed laughter at the 22 predefined time points. In the *"responsive laughter"* condition (RL), the virtual companion expressed amusement through laughter, in reaction to both the films and the participant's behavior. The system architecture and technical features of the three virtual companion conditions were tested in a pilot study (Niewiadomski et al. 2013).

In general, the laughter behavior of the virtual companion consisted of 22 animations of amusement laughter chosen from a population of 54 synthesized laughter clips in the laughter conditions, as well as blinking and head tilting to the left and right throughout the whole task to create the impression that the virtual companion was "active". The synthetized animation (facial expressions, head movements, audio) was displayed with a freely available virtual companion called "Greta" (for technical details see Niewiadomski et al. 2013).

Selection of pre-defined time points for the fixed laughter and fixed verbal amusement condition

The pre-defined times were chosen according to two criteria: continuous funniness ratings and expert assigned punch lines. First, all film clips were rated by 10–14 student raters in terms of their continuous perceived funniness utilizing the GTrace software (see Cowie et al. 2000, scale from "*not funny*" to "*irresistibly funny*").[6] Figure 1 shows the averaged and normalized funniness scores from the continuous ratings of the nonsense clips (for further information on the incongruity-resolution clips, see Niewiadomski et al. 2013).

Figure 1 shows the mean funniness scores (and the standard deviations) of the nonsense clips that were computed over all raters, showing sections with increases in funniness (apexes) over the film clips. These increases show that the film clips were varying in funniness within the clip (i.e., a prank consists of a non-funny build up and a punch line).

Secondly, three expert raters assigned "punch lines" to the stimulus films: Whenever the incongruous situation/prank was resolved for the person involved in the candid camera clips, and amusement could occur from observing the resolution moment, a peak (punch line) was assigned. In case of divergence, the three raters discussed the case until they came to an agreement. When matching the continuous funniness ratings by the student raters with the expert assigned punch lines, it was shown that the funniness apexes converged with the expert assigned punch lines for all pranks, apart from one outlier (see Niewiadomski et al. 2013 for further information on the candid camera pranks). For the nonsense humor clips, the funny moments were identified by the three expert raters which had been given a definition of nonsense humor and a representative collection of nonsense humor examples.

Fixed time points were chosen for the apexes of the funniness ratings in each clip by taking into account the overall number of funny moments in the clips (one to four for each clip). The chosen punch lines were then rank-ordered according to their intensity (stemming from the values of the continuous funniness ratings) to assign the verbal utterances and laughs of matching intensity to them. Also, the punch line moments were corrected for a 1.5 s delay in the rating/recording, due to the reaction latency of the subjects when conducting the continuous funniness rating.

Responsive laughter condition (RL)

In the responsive laughter condition, the virtual companion was programmed to use two sources of information to respond to the participant's behavior: Ten predefined time points of the fixed conditions, and the participant's laughter vocalizations. An interactive real-time system was built which is able to detect the participant's laughter and respond appropriately with synthetized laughter (see Niewiadomski et al. 2013). It is composed of several modules, where the single modules are responsible for

[5] Examples: "Oh, that is funny." "I liked that one." "I enjoyed that." "This is great!" "How amusing!" "This is hilarious!" "He is so funny.".

[6] Raters were instructed to watch the film clips one after another and rate their funniness. For this, they had a cursor that they could move from "*not funny*" to "*irresistibly funny*". The full length of the film clip had to be rated without breaks.

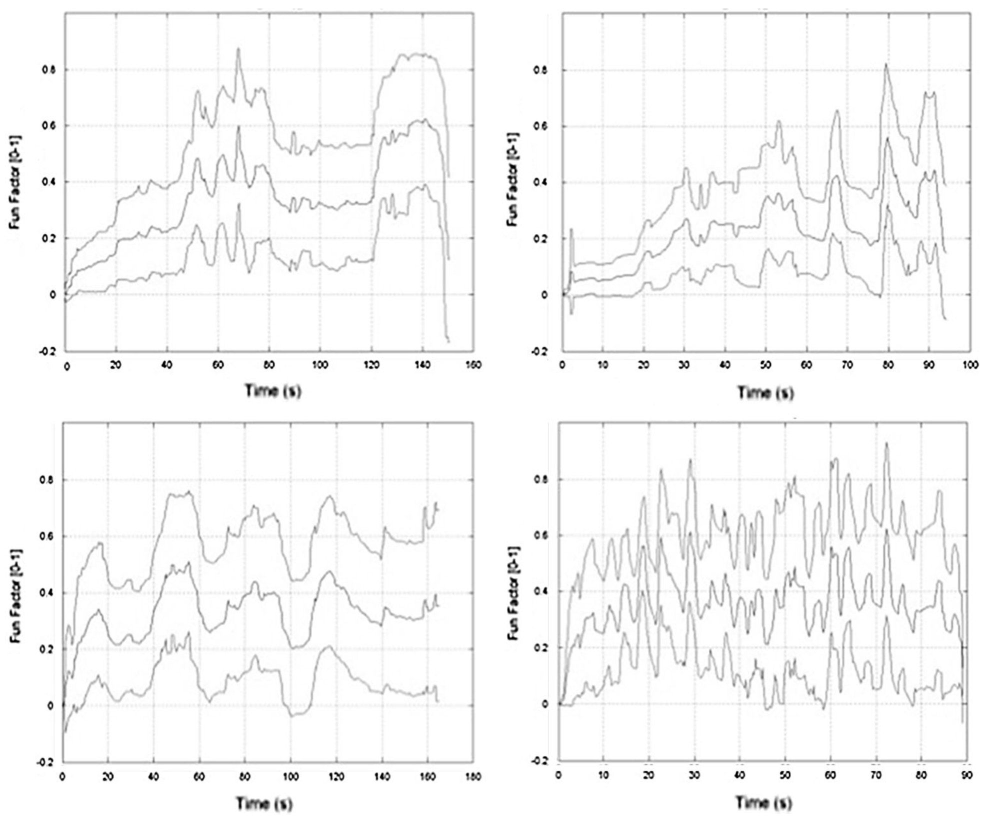

Fig. 1 Averaged and normalized continuous funniness ratings (mean ratings and standard deviations) of the nonsense film clips by 10–14 participants. Fun Factor = Normalized funniness ratings. *Top left* Mr. Bean at the dentist. *Top right* Simon's cat. *Bottom left* Little man dancing. *Bottom right* Funny dogs

laughter detection, analysis, and generation. The first module detects human laughter using the acoustic properties of the captured voice. Another module of the system is responsible for the decision taking task, i.e., the decision if and how to laugh. It uses the information of the detected laughs (intensity, duration) as well as the current funniness rating of the films (obtained by the continuous funniness ratings) and chooses the appropriate laughter response (intensity, duration). The decision-taking algorithm (trained on real data of interactive human dyads) is ensuring that the virtual companion takes similar decisions that humans would take under similar conditions.

Procedure

Experimental procedure

Participants were recruited through mailing lists and flyers announcing for a study where films should be watched and questionnaires completed. As an incentive, student participants were offered course credits and all participants were offered an individualized feedback on the questionnaire measures. At the experimental session, participants were welcomed by one of three experimenters (two male, one female; randomly assigned) and asked to fill in the trait version of the STCI-T, the GELOPH<15>, and the LAIEF-R general acceptance of virtual companions scale. Then, participants were asked to report their current cheerfulness, seriousness, and bad mood (STCI-S). Meanwhile, the participants were assigned randomly to one of the conditions (alone, FVA, FL, RL). After completing the questionnaires, the experimenter accompanied the participant to another room, where the participant was asked to sit in front of a TV screen (46″ LCD display). A second monitor was set to the right of the participant in an angle to simulate the possibility of the virtual companion "seeing" the film. Provisions were made that the participant could always see the companion on the separate monitor (which was blank in the control condition).

The participants were asked for verbal and written consent to have their respiration, shoulder, and body movements recorded (a non-intrusive respiration belt recording the movement of the thorax, two shoulder movement markers and a reference marker on the sternal). They were also given headphones to hear the virtual companion and the film sound. Then, the experimenter explained that the participant's task is to watch a film together with a virtual companion (in the experimental conditions: FVA, FL, RL), or that the participant's task is to watch some film clips alone (in the control condition) and that the experimenter would leave the room when the task started. Once the experimenter left the room, the virtual companion greeted the participant in the respective conditions ("Hi. I'm looking forward to watch this film with you. Let's start"), while in the control condition, the films just started. After the first set of films (five clips), the experimenter re-entered the room and asked the participant to report the current mood (STCI-S). Then, the experimenter left again for the participant to watch the next four film clips. In the virtual companion conditions, the virtual companion said "let's watch the second film now". After the films, the experimenter entered the room again and accompanied the participant back to the location where the post measure of the STCI-S, as well as the LAIEF-positive experience and a single item measure on the funniness of the films were filled in. After all questionnaires were completed, the experimenter debriefed the participant and asked for written permission to use the obtained data. During the whole session, a camera on top of the television screen allowed for the frontal filming of the head and shoulder, as well as upper body of the participant.

Facial action coding

Full color, digital format films, which gave a close-up, head-on view of the participant's face were recorded. The facial responses were assessed with the Facial Action Coding System (FACS; Ekman et al. 2002). Two certified FACS coders identified and scored the Action Units (AUs) of DDs, defined by the presence of a symmetric and timely coincident AU12 and AU6. The AU6 and AU12 may be accompanied by a tightening of the eyelids (AU7), as well as mouth opening, jaw dropping (AU25, AU26, AU27) but no other action unit (see Ekman et al. 1990; Platt et al. 2013). A random selection of sixteen participant films was double coded and an inter-rater reliability of K = .81 was obtained. The Kappa coefficient was scored as an agreement when both the AU and its AU intensity (FACS conventions of intensity threshold of A = trace, B = slight, C = marked to pronounced, D = severe to extreme, to E = maximum) was correctly assigned by the coders (following the guidelines of Ekman et al. 2002). Furthermore, the frequency of laughter vocalizations was assessed.

Results

Preliminary analysis

First, descriptive statistics of the self-report and nonverbal measures were computed. To ensure the comparability of the conditions, oneway ANOVAs with age, trait variables and mood (pre experiment) as dependent variables and the conditions as grouping variable were computed. As expected, there were no differences with respect to age or personality between the four conditions (all n.s.). Also, the participants did not differ in their state cheerfulness, seriousness, and bad mood before the experiment (all n.s.). The distribution of gelotophobia was comparable to samples of Swiss German adults (see Ruch and Proyer 2008) and nine individuals yielded a score above the cut-off point for gelotophobia (three in the control condition, one in the FVA, two in the FL, and three in the RL condition).

Convergence between objective and subjective data

To investigate the convergence between subjective and objective data, Pearson correlations between the frequency of DDs, laughter vocalizations and the perceived funniness of the films were computed. The correlation between the perceived funniness and the frequency of DDs shown was expectedly positive, $r(66) = .27$, $p = .03$. The same positive relation was observed for laughter vocalizations, $r(69) = .26$, $p = .03$. Next, Pearson correlations between the frequency of DDs and laughter vocalizations were computed for each condition separately. In the control condition where participants watched the funny films in solitude, the correlation between the perceived funniness and the frequency of DDs shown was expectedly high, $r(19) = .70$, $p = .001$. The same was observed for laughter vocalizations, $r(21) = .48$, $p = .02$. In the conditions with a companion, the correlations between funniness and the DDs were numerically lower, DDs FVA: $r(15) = .23$, $p = .45$; FL: $r(17) = .21$, $p = .41$; RL: $r(17) = .15$, $p = .56$. Also for correlations of funniness and laughter vocalizations, the coefficients were generally lower, FVA: $r(14) = .19$, $p = .51$; FL: $r(17) = .48$, $p = .05$; RL: $r(17) = .10$, $p = .76$. This indicates an influence of presence of the companion on the perceived funniness of the films.

Hypotheses testing

The hypotheses H1–H3 were tested with separate analyses for each dependent variable (laughter vocalizations, DDs, self-reported positive experience). We utilized a priori planned contrasts (Winer et al. 1991) for H1–H3 on laughter vocalizations, DDs and self-reported positive experience. In respect to cheerful mood as dependent variable, we computed a repeated measures ANOVA with the experimental condition (alone, FL, FVA, RL) and trait cheerfulness (high vs. low) as independent variables, the three time points of state cheerfulness as repeated measures (pre, between, post), and the intensity of cheerful mood as dependent variable. For H4, the influence the general acceptance of virtual companions (H4a) and gelotophobia (H4b) on the amusement, we utilized correlations.

Table 1 Mean and SD of the state measures and nonverbal responses for the groups split by condition and trait cheerfulness

	Alone				Fixed verbal amusement				Fixed laughter				Responsive laughter			
	Low		High		Low		High		Low		High		Low		High	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Laughter voc.	1.56	3.97	13.84	12.48	12.00	10.62	16.63	6.63	10.43	8.16	16.65	10.67	13.43	9.71	13.57	7.18
DD frequency	10.63	4.72	19.17	11.41	14.67	6.53	17.29	5.53	17.29	7.41	18.11	6.20	20.15	10.85	18.25	7.61
DD intensity	2.45	.81	2.59	.52	2.78	.52	2.70	.18	2.68	.17	2.52	.49	2.32	.68	2.43	.69
Positive experience					1.98	.68	2.02	.79	1.76	.55	2.45	.94	1.95	.54	2.70	.93
STCI-S cheerfulness																
Pre	22.71	4.20	26.63	4.24	22.63	6.72	26.50	3.66	20.25	5.15	30.00	4.10	25.50	5.10	28.50	5.50
Between	29.83	3.79	32.50	3.69	27.86	4.29	30.63	3.82	23.43	7.14	34.27	4.58	30.38	7.13	32.43	3.46
Post	26.69	6.65	33.63	3.16	29.13	4.94	30.88	3.52	22.14	6.98	34.82	4.29	30.38	5.48	32.14	2.19

$N = 68$–87

M = mean, SD = standard deviation, STCI-S = State-Trait Cheerfulness Inventory (Ruch et al. 1996, 1997), Pre = before the experiment, Between = after the first five film clips participants filled in the STCI-S and then continued with the next films, Post = after the experiment, Low/high = low/high in trait cheerfulness

Laughter vocalizations and DDs towards the films and virtual companion

First, H1–H3 were tested on the laughter vocalizations and DDs. For the frequency of laughter vocalizations, Table 1 shows the means and standard deviations of the participant groups (four experimental conditions and Median split for high and low trait cheerful individuals, $M_d = 62$, cell sizes N from 6 to 13).

The initial ANOVA indicated that the groups differed from each other in the frequency of laughter vocalizations, $F(7, 65) = 2.34$, $p = .036$, $\eta^2_p = .220$ (see Table 1), and the contrasts (H1–H3) were computed. The results are presented in Fig. 2.

Figure 2 shows that watching the films with a virtual companion compared to being alone led to more laughter ($p = .005$), confirming hypothesis H1. In line with the expectations for hypothesis H2a, those high in trait cheerfulness generally laughed more than the low trait cheerful individuals ($p = .011$). In more details, looking at individuals high and low in trait cheerfulness separately, the contrast showed that individuals high in trait cheerfulness did not differ from each other in the amount of laughter uttered across the experimental conditions ($p = .657$). However, in individuals low in trait cheerfulness, being with a virtual companion led to more laughter than being alone, confirming hypothesis H2b ($p = .007$). Contrary to H3, the responsive companion did not elicit more laughs than the pre-scripted companion ($p = .889$).

The same ANOVA with a priori contrasts was repeated for the DDs. The contrasts showed that H1 was disconfirmed: being with a companion did not lead to more DDs than being alone ($p = .686$). Nevertheless, the high trait cheerful showed more DDs than the low trait cheerful, confirming hypothesis H2a ($p = .002$). Though low trait cheerful individuals showed numerically more DDs when being with a companion compared to being alone, the contrast failed significance ($p = .057$; H2b). Furthermore H3 was disconfirmed: the responsive companion did not lead to more DD's than the pre-scripted companion ($p = .168$).

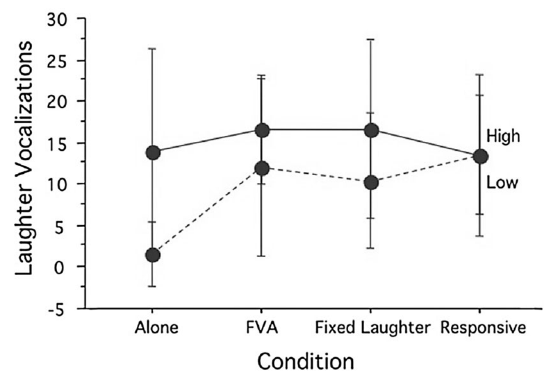

Fig. 2 Laughter vocalizations towards the funny films and the virtual companion in four experimental conditions, participants split in groups of high and low trait cheerfulness. Alone = control condition, FVA = fixed verbal amusement, Responsive = responsive laughter condition, High = high scores in trait cheerfulness, Low = Low scores in trait cheerfulness

Positive experiences elicited by the interaction with the virtual companion

Next, H2 and H3 were investigated for the self-reported positive experience elicited by the virtual companion.

Table 1 shows the means and the standard deviations of rated positive experience for experimental groups with a virtual companion present. The ANOVA indicated no difference in the positive experience, $F(5, 47) = 1.55$, n.s.. Therefore, H2 and H3 were disconfirmed: Trait cheerful individuals did not report higher positive experience than low trait cheerful individuals (H2a). Low trait cheerful individuals did not report higher positive experience when being with a companion compared to alone (H2b), and the responsive companion did not lead to higher positive experience than the pre-scripted (H3).

Participant's cheerful mood

To investigate H1–H3 in respect to participants' amusement-related mood (state cheerfulness), a repeated measures ANOVA for the changes in state cheerfulness at the three measurement time points (pre, between, post experiment) was computed. The four experimental groups (alone, FVA, FL, RL) and trait cheerfulness (high vs. low) entered as factors and the intensity of cheerful mood as dependent variable. After the sphericity test, a Greenhouse-Geisser correction of the degrees of freedom was indicated ($\varepsilon = .781$). Table 1 shows that state cheerfulness differed at the three measurement time points, $F(1.65, 107.28) = 50.03$, $p = .001$, $\eta_p^2 = .431$. This finding is in line with the expectation that the experiment elicits amusement and hence increases cheerful mood. Pairwise comparisons showed that cheerfulness increased for time point two and three compared to before the experiment (both $p = .001$), while the measurement between and post experiment did not differ from one another ($p = .781$). This indicates that the films increased the amusement-related mood from before the film-watching task to the middle and remained stable and elevated until the end of the experiment.

The main effect for the experimental condition was not significant, $F(3, 66) = 1.26$, $p = .295$, disconfirming hypothesis H1 (being with a companion leading to more cheerful mood than being alone), as well as hypothesis H3 (the responsive companion leads to more cheerful mood than the pre-scripted companion). Still, hypothesis H2a was confirmed, as the results showed that high trait cheerful individuals had higher state cheerfulness scores than low trait cheerful individuals, $F(1, 66) = 26.68$, $p = .001$, $\eta_p^2 = .288$. None of the two-way or three-way interactions between state cheerfulness at three time points and the two factors (experimental condition, trait cheerfulness high vs. low) were significant (all $p > .292$). Therefore, H2b was disconfirmed: low trait cheerful individuals did not profit more from the company in terms of higher state cheerfulness compared to being alone.

The general acceptance of virtual companions and gelotophobia

To investigate whether the general acceptance of virtual companions and the fear of being laughed at influenced the amusement elicitation, Pearson correlations of the general acceptance of avatars scale, the GELOPH<15> and the amusement related outcomes (DDs, laughter vocalizations, positive experience, cheerful mood) were computed (see Table 2).

The results in Table 2 show that the general acceptance of virtual companions was a good predictor of laughter vocalizations, positive experience, and the cheerful mood at the three measurement time points (over all four experimental conditions), in line with the hypothesis H4a. Surprisingly, gelotophobia did not reveal strong correlations to the amusement-related outcome measures. This indicates that the fear of being laughed at does not strongly

Table 2 Pearson correlations of gelotophobia, the general acceptance of virtual companions and the dependent variables on the elicited amusement

	Acceptance	DD frequ.	Laughter	Positive exp.	CH pre	CH between	CH post
Gelotophobia	−.02	−.03	−.14	.02	−.09	$-.19^{+}$	−.17
Acceptance	1	.15	$.20^{+}$	.33*	.21*	.26*	.29**
DD frequency		1	.85**	.16	.18	.27*	.29*
Laughter voc.			1	.22	.20	.30*	.34**
Positive experience				1	.22	.17	.24
STCI-S cheerfulness							
CH pre					1	.61**	.55**
CH between						1	.84**
CH post							1

$N = 66$ 87

Acceptance = general acceptance of virtual companions, DD = Duchenne display, CH = cheerfulness, Positive exp. = positive experience

* $p < .05$; ** $p < .01$; $^{+}$ $p < .05$ one-tailed

inhibit the amusement elicitation when watching films with a companion or alone, contrary to the expectations of H4b.

Discussion

This is the first experiment to investigate the impact of a laughing virtual companion and personality traits on the elicitation of amusement. Most importantly, there are three main findings in line with our hypotheses H1 and H2: firstly, watching funny films with a virtual companion leads to more overt amusement (laughter) than watching films alone (H1). Secondly, high trait cheerfulness generally goes along with a stronger elicitation of amusement, irrespective of the experimental condition and the assessment method (self-report or objective measurement; H2a). Thirdly, low trait cheerful individuals expressed more overt amusement (DDs, laughter) when being with a companion compared to being alone (H2b).

Hypothesis H1: Being alone versus being with a virtual companion

Converging with findings on human participants (e.g., Chapman and Chapman 1974), the virtual companion fostered *overt* amusement responses compared to being alone (H1). Thus, the virtual companion served as an additional source of amusement next to the funny films. Interestingly, for participants watching the film alone, a robust correlation between the frequency of facially expressed amusement and the perceived funniness of the films was found (for the factors affecting the size of these correlations see, for example, Ruch 1995). In contrast, the conditions with the virtual companion led to a higher number of laughter vocalizations and DDs compared to the control condition, but the correlations to the perceived funniness were weaker (also due to the more restricted variance). Therefore, the virtual companions' presence led to further laughter responses (and possibly mimicry of laughter in the RL condition) and has served as a source of amusement itself. Importantly, the effect of virtual companionship was only found for the objective measures of amusement, but not in the self-reported cheerful mood: All participants experienced steep increases in cheerful mood throughout the experiment, independent of the condition. Alternatively, the virtual companion might have facilitated overt amusement responses due to a facilitation through the "social context" (i.e., being in company).

Hypothesis H2: High versus low trait cheerfulness

In general, high trait cheerful individuals experienced and expressed more amusement than low trait cheerful individuals (H2a). For high trait cheerful individuals, it did not matter whether they were alone or with the virtual companion: the film clips were equally strong elicitors of amusement (laughter, DDs, state cheerfulness). This supports the notion that for individuals high in trait cheerfulness, the threshold for amusement is habitually lower: they experience amusement quicker, more intensely, and for a variety of stimuli (see Ruch and Hofmann 2012).

In contrast to this, being alone or being with a virtual companion did matter for the low trait cheerful individuals (H2b). Low trait cheerful individuals laughed more often when being with a companion compared to being alone: Their overt amusement responses were even lifted to comparable levels as for the high trait cheerful individuals, proving the usefulness of the virtual company for low trait cheerful individuals. Thus, low trait cheerful individuals benefitted more from the virtual company than high trait cheerful individuals (in line with hypothesis H2b). Similar findings of stronger benefits for low trait cheerful individuals were obtained from a cheerfulness intervention, where the positive outcome effects were stronger for low compared to high trait cheerful individuals (see Papousek and Schulter 2008). Still, this effect was only found in the objective measures (DDs and laughter). In respect to the self-reported state cheerfulness, similar increases in state cheerfulness were found for low trait cheerful individuals in all conditions. Furthermore, the virtual companion elicited comparable levels of positive experience for high and low trait cheerful individuals. This might be explained by the fact that low trait cheerful individuals really benefitted from the company and thus experienced comparable levels of positive experience as the high trait cheerful individuals.

Hypothesis H3: Responsive versus pre-scripted acting virtual companions

Surprisingly, hypothesis H3 was disconfirmed for all amusement-related outcome variables: neither nonverbal (laughter vocalizations, DDs) nor self-reported amusement (positive experience, cheerful mood) revealed a difference for the participants interacting with the pre-scripted or the responsive virtual companion. We could not substantiate the hypothesis H3 that the responsive companion would foster mimicry and emotional contagion of laughter more so than the pre-scripted acting companion. One might argue that the amusement elicitation through the films and the virtual company worked well and a responsive (compared to a pre-scripted) companion could only add little more variation. Furthermore, the responsiveness of the virtual companion in the RL condition depended also on the laughter utterances of the participant. Thus, not all participants had the same amount of responses by the virtual companion. Although there was a “fit” between the amusement of the participant and the amusement expression of the virtual companion—as the virtual companion responded similarly and similarly often to the participant—this difference in the laughter frequency within the RL condition might have blurred a potential positive effect of the responsiveness.

Hypothesis H4: The general acceptance of virtual companions and gelotophobia

As expected, there was an impact of the general acceptance of virtual companions on the responses in the experiment (H4a). Generally liking to interact with virtual companions went along with expressing more laughter, reporting more positive experience elicited by the virtual companion and higher self-rated state cheerfulness, independent of the experimental condition. Therefore, it is essential to control for this belief pattern when evaluating virtual companions.

Higher gelotophobia related to less cheerful mood during and after the experimental task. Surprisingly, no strong negative relations were found to the self-reported positive experience and the nonverbal expression of amusement, leading to a rejection of hypothesis H4b for gelotophobia. In fact, gelotophobia revealed a zero-correlation to the self-reported positive experience over all experimental conditions. This finding might be due to the experimental treatment: while gelotophobia might be unrelated to the positive experience in the FVA condition where the virtual companion just utters amusement related sentences (but does not laugh), it might be that gelotophobia relates negatively to the positive experience in the conditions where the companion utters laughter (i.e., the stimulus that gelotophobes fear). Unfortunately, the small number of gelotophobes in the current sample did not allow for an in-depth analysis of this notion. Still, such an analysis would help differentiating between gelotophobia linking to the dislike of amusement, or the specific dislike of the laughter stimulus (while being unaffected when amusement is expressed verbally). Moreover, future studies might focus on the responses of gelotophobes towards the companion’s laughter to find out which aspects of the laughter are seen as threatening or aversive. In consequence, virtual companions should be programmed to de-amplify facial and vocal features that go along with perceived threat.

Limitations

The current study was a first attempt to study the amusement elicitation with a virtual companion. Still, many questions about the generalizability of the observed phenomena remain unanswered. Firstly, we did not check whether participants also experienced the virtual companion as a source of amusement: Participants might have *laughed at* the virtual companion because they perceived it as “ridiculous”. In this case, the virtual companion would be “laughed at” which might also lead to more amusement, but is not the effect aspired.

Secondly, another limitation of the study targets the choice of conditions: The current setting did not allow for a direct comparison of the effects of human and virtual companions on the elicitation of amusement. Ideally, participants would be watching funny films either with a stranger, a friend, or a virtual companion. This would allow comparing the influence of a virtual companion compared to another (human) companion and shed light on mimicry and emotional contagion processes.

Thirdly, the number of individuals above the cut-off point for gelotophobia was not sufficient to investigate the responses of gelotophobes in more detail. Hence, the current analyses focused on correlations of the full gelotophobia continuum in a normal adult sample (where the majority of individuals reported no or only little fear of being laughed at). These correlations revealed relations of the GELOPH<15> mostly at the lower end of the continuum to the outcome measures (see Ruch et al. 2014). Evidently, the bias of gelotophobes in laughter perception and evaluation becomes more severe in individuals above the cut-off point (or extreme scores). Therefore, the current analyses underestimate the influence of gelotophobia on the amusement elicitation when being with a laughing virtual companion, thus limiting the generalizability of the conclusions in respect to gelotophobia. Future studies might include bigger samples of gelotophobes to verify the current results.

Fourth, we did not explicitly check whether the participants were aware that the virtual companion was acting independent of human control. To explain the term avatar, we used the description “avatars are virtual images of humans that appear for example in computer games and on websites”. This link to computer games and websites might imply independence of direct operation through a human. Still, as the understanding of “avatar” can refer to a virtual agent being operated by a human, it might be that certain participants assumed that the virtual companion was driven by a human (e.g., “wizard of Oz” technology). The definition did not make this explicit. If participants believed that the virtual companion was driven by a human (meaning they were communicating with another person), the responses and cognitions might have differed (as opposed to believing that the companion was pre-programmed). Though none of the free-answer comments at the end of the study and the debriefing explicitly related to the participant believing that the virtual companion was operated by a human, future studies should assess this directly.

Fifth, our study only utilized one embodiment (a virtual realistic 3D woman) and one synthetic female voice. Future studies should test different virtual representations (e.g., male and female), as well as different levels of the synthesis precision (e.g., a simple cartoon-like presentation vs. a more human-like presentation).

Implications

The novelty of this study lies in the application of a virtual companion in a setting eliciting positive emotions. Moreover, our results solidify knowledge on the role of personality in the elicitation of positive emotions (i.e., trait cheerfulness is an important predictor of amusement responses) and add to the research on the effect of social influence on amusement. The results further showed that the virtual companion was particularly suitable for low trait cheerful individuals. In respect to the application of these results, it was shown that positive emotions are beneficial to individuals' well-being (e.g., Diener et al. 1999; Fredrickson and Joiner 2002). Therefore, time and space flexible interventions fostering positive emotions (like amusement) should be developed/adapted for virtual environments. Amusement expressing virtual companions might increase the participant's positive affect and motivation to complete the intervention, especially if the individuals have higher thresholds for amusement. Also, an assessment of personality traits can give indication which participants are suitable for the intervention (i.e., low trait cheerful), bias the evaluation (e.g., when disliking virtual companions), or whether such interventions need to be adapted for different trait configurations.

Methodologically, the inclusion of objective data is an important addition to self-report measures, as the combination of subjective and objective data gives insight into the differential effects the laughing virtual companion has on the cognitive, emotional and behavioral level: we found a small correlation between the funniness of the films and the overt amusement responses across all conditions. The reported correlations might appear to be low, however, it does not require the assumption that rated funniness and overt facial expressions reflect strongly different aspects of amusement (Ruch 1995). Looking at the correlations within the experimental conditions compared to the control condition, the experimental conditions with the virtual companion elicited more laughter, although the perceived funniness of the films was higher in the control condition. This result indicates that the virtual companion was a source of amusement by itself that increased the overt amusement responses.

Implementing (laughing) virtual companions into psychological research offers exciting new research opportunities, as virtual companions are well-controllable and can be used for interactions with a given set of behavior rules (see for example Rinck et al. 2010, for a study of approach behavior of socially anxious towards avatars in a virtual shopping center). Adequately responding virtual companions may help overcoming standardization problems within studies and interactions with virtual companions might serve to investigate emotional responses, cognitions, and motivation. Also, laughing virtual companions might be applied in decoding studies on the morphology of laughter, as they allow for a perfect control over the parameters of laughter displays in face and voice.

Conclusion

Watching funny films with a virtual companion (compared to being alone) increased the expression of laughter and DDs. However, it did not increase felt cheerfulness. All amusement dependent measures increased with high trait cheerfulness when compared to low trait cheerfulness. Watching funny films with a virtual companion increased people's sociability and expressive responses (laughter, DD) but not their subjectively felt cheerfulness, which is a function of the stimuli and personality, but not the virtual companion. Thus, the virtual companions (or other amusement assisting interventions) are beneficial for the elicitation of overt positive affect responses, especially in individuals with higher thresholds for amusement. This knowledge may be used in a variety of research settings and applications where virtual agents are embedded to elicit positive responses.

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